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Original Article

Association of socioeconomic status with sleep disturbances in the Swiss population-based CoLaus study

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Highlights

- We examined the association of socioeconomic status (SES) with subjective and objective sleep.
- Analyses are based on a population-based sample of the city of Lausanne, Switzerland (*N*=3391).
- We found SES differences in sleep quality, latency and insomnia in both sexes (subjective sleep).
- Women with low SES also had higher daytime sleepiness and shorter sleep duration.
- Results from polysomnography confirmed poorer sleep patterns among participants with low SES.

ABSTRACT

Objective: To examine the association of SES with subjective and objective sleep disturbances and the role of socio-demographic, behavioural and psychological factors in explaining this association.

Methods: Analyses are based on 3391 participants (53% female, aged 40–81 years) of the follow-up of the CoLaus study (2009–2012), a population-based sample of the city of Lausanne, Switzerland. All participants completed a sleep questionnaire and a sub-sample (*N*=1569) underwent polysomnography.

Results: Compared to men with a high SES, men with a low SES were more likely to suffer from poor sleep quality (prevalence ratio (PR) for occupational position=1.68, 95% Confidence Interval (CI): 1.30–2.17), to have long sleep latency (PR=4.90, 95%CI: 2.14–11.17), insomnia (PR=1.47, 95% CI: 1.12–1.93) and short sleep duration (PR=3.03, 95% CI: 1.78–5.18). The same pattern was observed among women (PR=1.29 for sleep quality, 2.34 for sleep latency, 2.01 for daytime sleepiness, 3.16 for sleep duration, 95%CIs ranging from 1.00 to 7.51). Use of sleep medications was not patterned by SES. SES differences in sleep disturbances were only marginally attenuated by adjustment for other socio-demographic, behavioural and psychological factors. Results from polysomnography confirmed poorer sleep patterns among participants with low SES (p<0.05 for sleep efficiency/stage shifts), but no SES differences were found for sleep duration.

Conclusions: In this population-based sample, low SES was strongly associated with sleep disturbances, independently of socio-demographic, behavioural and psychological factors. Further research should establish the extent to which social differences in sleep contribute to socioeconomic differences in health outcomes.

Keywords:
Socioeconomic status
Sleep
Cohort
Population-based

1. Introduction

Sleep is an essential state allowing restoration and recovery of brain functions, with a major impact on human health and functioning. Insufficient sleep has been related, among others, to an increased risk of cardiovascular and metabolic disorders, and of vehicle accidents and workplace injuries, and to poorer cognitive performances and mental health [1–9]. In high-income countries, about half of the population

reports suffering from sleep disturbances [10,11]. The prevalence of sleep complaints has risen steadily over the last decades [12–14] and is expected to increase further in response to population ageing, raising prevalence of obesity, and changes in the labour market (including higher female employment rates, increasing working hours and demand for shift works [15]). As a consequence, sleep disorders and deprivation are growingly being recognized as major public health issues and the identification of their determinants as a research priority [16,17].

The prevalence of sleep disturbances generally increases with age [18] and is higher among women than men [19–21]. Other common determinants include heavy drinking and obesity, stress, anxiety and several psychiatric disorders [21–23]. As the prevalence of these risk factors is higher in people with low socioeconomic status (SES), individuals with low SES are potentially more likely to suffer from poor sleep. Indeed, a strong social patterning of sleep has been observed in many studies [24–29], with some exceptions [30,31]. Some studies have even suggested that socioeconomic differences in sleep disturbances might explain part of the socioeconomic gradient in other health outcomes [30,32,33].

While social differences in sleep disturbances are frequently reported, studies assessing the social patterning of sleep are very heterogeneous regarding the indicators of SES examined and the sleep characteristics considered [24–29,31]. In particular, previous studies have generally associated a single indicator of SES with a single indicator of sleep. However, both SES and sleep have multiple dimensions, and various aspects of low SES are likely to impact sleep correlates differently. Moreover, the majority of studies have used self-reported assessments of sleep characteristics only, and results might have been biased by social differences in the subjective evaluation of sleep. Finally, very few studies have formally assessed the contribution of other risk factors to the association between SES and sleep disturbances.

The objective of this study was therefore to assess the association between two indicators of SES (education and occupational position) and a variety of subjectively and objectively measured sleep disturbances after adjustment for other socio-demographic, behavioural and psychological factors. We hypothesize that sleep disturbances are patterned by SES. Moreover, we expect that socio-demographic, behavioural and psychological factors account for a substantial part of socioeconomic differentials in sleep.

Methods

Study population

The CoLaus Study is a prospective study conducted in Lausanne, a French-speaking Swiss city of approximately 120,000 inhabitants. The study was approved by the Institutional Ethics Committee of the University of Lausanne [34]. The initial recruitment took place between June 2003 and May 2006 and

enrolled 6733 participants (3544 women) aged 35–75 years, with a participation rate of 41%. The present study is based on the first follow-up of the CoLaus study, which was conducted between April 2009 and September 2012 and included all CoLaus participants willing to be re-contacted (*N*=5064). Average follow-up time was 5.5 years. At follow-up, participants attended a single visit which included, as in the baseline assessment, an interview, a physical exam, and blood and urine collections in the fasting state. Information on demographic data, socioeconomic and marital status, lifestyle factors, personal and family history of disease, cardiovascular risk factors and treatment was collected through questionnaires. Supplementary Figure S1 shows the selection flow of participants included in the present study. Of the 5064 participants included in the CoLaus follow-up, 1673 were excluded from the present analysis because they had missing data on sleep disturbances (*N*=986 for sleep quality, 433 for sleep latency, 646 for sleepiness, 405 for sleep duration, 549 for insomnia, 473 for sleep medications) on indicators of socioeconomic status (*N*=19 for education) or on mediating factors (*N*=883 for physical activity, 57 for smoking, 65 for obesity, 72 for employment status, 93 for coffee consumption, 642 for psychological factors), categories not mutually exclusive. The analysis was based on the remaining 3391 participants (53% female). Those excluded tended to have a lower educational level (60.3% versus 49.2% in the lowest educational group, $p<0.001$) and had a higher prevalence of sleep disturbances (42.4% vs 33.6% reporting poor sleep quality). Excluded participants were older than those included (59.1 years vs 56.3 years, $p<0.001$). Analysis on occupational position were further restricted to 2184 participants (49% female) who were currently employed at study examination.

Measures

Subjective sleep assessment

Sleep habits were collected for all CoLaus participants through validated questionnaires assessing sleep duration and quality [35,36]. Sleep quality was derived from the Pittsburgh Sleep Quality Index (PSQI) [35], a 19-item questionnaire evaluating sleep patterns over the previous month. Items are used to derive seven clinically based sub-scales (sleep quality, latency, efficiency, duration and disturbances; daytime dysfunction and use of sleep medications). Subscales ranging from 0 to 3 are then summed to obtain the global PSQI score (range: 0–21). High PSQI score values represent poorer sleep quality. For bivariate analysis, we dichotomized the score and defined “poor sleep quality” as a PSQI score > 5.

Sleep latency represents the self-reported average length of time before falling asleep in minutes (in the previous month). “Long sleep latency” was defined as sleep latency > 30 minutes.

Daytime sleepiness was derived from the Epworth Sleepiness Scale [36]. Participants rated how likely they were to doze off in different daily situations using a scale from 0 to 3. Items were then summed to obtain

the total daytime sleepiness score (range: 0–24). Scores > 10 were considered as “excessive daytime sleepiness”.

Sleep duration represents the self-reported average hours of sleep in the previous month. A sleep duration <5 hours/night was considered as “short sleep duration”.

Insomnia was assessed using two items from the PSQI, “sleep latency of more than 30 minutes” or declaring “waking up in the middle of the night or too early in the morning”. Insomnia was considered if participants reported to suffer from one of the two disturbances at least three to four times a week.

Use of sleep medications was assessed using the PSQI item "During the past month, how often have you taking medicine to help you sleep?" and was coded as "no" if participants reported not having used sleep medications over the previous month, and "yes" otherwise.

Objective sleep assessment

Overall, 3051 consecutive CoLaus participants were invited to undergo a complete full night in-home polysomnographic (PSG) recording (HypnoLaus nested study). A total of 2162 participants (71%) accepted and underwent the PSG between 2009 and 2013. In the present analysis, only 1569 participants with complete data are included (Supplementary Fig. S1). Analysis on occupational position were further restricted to 1011 participants who were currently employed at study examination.

During a visit at the Center for Investigation and Research in Sleep (Lausanne University Hospital, Switzerland), certified technicians equipped the participants with a PSG recorder (Titanium, Embla® Flaga, Reykjavik, Iceland). The recorder was set between 5 and 8 pm before the participants returned home. All sleep recordings took place in the patients’ home environment and included a total of 18 channels: six for electroencephalography (F3/M2, F4/M1, C3/M2, C4/M1, O1/M2 and O2/M1), two for electrooculography, three surface electromyography channels (one submental region, two anterior tibialis muscle), one for electrocardiogram, nasal pressure, thoracic and abdominal belts, body position, oxygen saturation and pulse rate in accordance with the AASM 2007 recommended setup.

All PSG recordings were manually scored by two trained sleep technicians using Somnologica software (Version 5.1.1, by Embla® Flaga, Reykjavik, Iceland) and reviewed by an expert sleep physician. Random quality checks were performed by a second sleep physician. Sleep stages and arousals were scored according to the American Association of Sleep Medicine (AASM) 2007 recommendations [37]. For

the purpose of this study, we considered the following objective sleep variables: total sleep time (time spent in sleep stage (stage 1, 2, 3 and REM)), sleep latency (latency to sleep stage 1 after sleep onset), slow wave sleep (percentage of time spent in stage slow wave sleep during total sleep time), sleep efficiency (the ratio of time spent asleep (total sleep time) to the total recording time), and stage shifts (number of sleep stage transitions from one sleep stage to another).

Socioeconomic status (SES)

Socioeconomic status is often assessed through three indicators: education, occupational position and income. As information on income was not available in our study, only educational level and occupational position were used as indicators of SES. Educational level was extracted from the CoLaus baseline questionnaire. It was assessed as the highest qualification achieved and categorized as ''high'' (tertiary education), ''middle'' (upper secondary education or post-secondary non-tertiary education, including vocational education) and ''low'' (lower secondary education or lower). Information on occupational position for participants who were currently employed was obtained in the CoLaus follow-up questionnaire through the question "Which is your current occupation" (10 possible answers). This was further categorized as "high" (entrepreneurs, professionals, higher managers), "middle" (self-employed, lower managers, skilled clerks) and "low" (unskilled clerks, farmers, skilled manual workers, unskilled manual workers).

Other factors

Socio-demographic factors considered were age, sex, employment status (employed full time/not), marital status (married or cohabiting/ living alone) and place of birth (Switzerland/other). Behavioural factors were assessed through questionnaire in the follow-up examination. We considered: current smoking (yes vs no), heavy drinking (> 21/> 14 alcohol units/week in men/women vs lower amounts), sedentary behaviour [38] (lower tertile vs higher tertiles of total weekly energy expenditure in kcal/week, excluding energy expenditure during sleep), high coffee consumption (more than 6 cups/day), and obesity (body mass index >30 kg/m^2).

Psychological factors were assessed through questionnaire using the Center for Epidemiologic Studies Depression Scale (CES-D) [39,40]. The CES-D consists of 16 negative affect and 4 positive affect items, such as "I felt depressed", "I felt lonely" and "I was happy". Participants were asked about the number of days on which they experienced depressive symptoms during the previous week. Each item was accompanied by a standard four-point Likert scale ranging from 1=none to 4=five days or more per week. Scores ranged from 0 to 60, higher scores indicating more symptoms of depression. Depression was considered for a score ≥ 16

points. Four other factors can be identified using selected items of the CES-D and were used in this study: "somatic complaints", "depressed affect", "positive affect" and "interpersonal problems". The CES-D has been validated as an accurate tool for depression assessment in the general population [40].

Statistical analysis

Statistical analyses were conducted using STATA Version 13.1 (Stata Corp, College Station, TX, USA). Analyses for subjective sleep were performed separately for men and women; because of a reduced sample size, analyses for objective sleep were conducted in men and women together and sex adjusted (p for interaction between SES and sex > 0.05). For each educational and occupational group, least-squares regression was used to calculate age-adjusted prevalence rates or mean values (with their standard errors (SE)) of sleep disturbances. As logistic regression has been shown to produce biased estimates of relative inequalities when the prevalence of the health outcome is relatively high (i.e.: >10%) [41], the association between SES indicators and the dichotomized sleep variables was assessed using Poisson regression with robust standard errors [42,43], adjusted for age. The same model was applied to assess the associations of other socio-demographic, behavioural and psychological factors with sleep disturbances. The contribution of socio-demographic characteristics others than SES (and age), behavioural and psychological factors in explaining social differences in sleep disturbances was determined by the percent reduction in the coefficient for SES after inclusion of the mediating factors in question to the age adjusted models (model 1), using the formula

$$100\times (\beta_{\text{Model 1}} - \beta_{\text{Model 1 + socio-demographic, behavioural, psychological factors}})/(\beta_{\text{Model 1}})$$ [44].

Statistical significance was considered for $p<0.05$.

Results

Table 1 shows the sample characteristics by sex. A higher proportion of women than men used sleep medications, reported high somatic complaints and positive affect, and had poor sleep quality, long sleep latency and insomnia (all $p<0.001$). A higher proportion of men than women were working full-time, were married or cohabiting, were heavy drinkers , obese and depressed (all $p<0.001$).

Comment [AU1]: Author : do you mean positive effects ? Of what?

Mean values and prevalence of sleep disturbances by socioeconomic indicators are presented in Fig. 1. Men with a low educational level or occupational position had poorer sleep quality, longer sleep latency and higher prevalence of insomnia ($p<0.001$). A similar pattern was observed in women for sleep quality and sleep latency. However, women with a low vs high occupational position also had higher daytime sleepiness scores (Epworth mean score=14.4 vs 6.2, $p<0.012$) and a shorter sleep duration (mean hours=6.8 vs 7.1, $p<0.004$).

Results for the association of socio-demographic, behavioural and psychological factors with sleep disturbances are reported in Table 2. Only psychological factors were strongly and consistently associated with most sleep disturbances in both sexes (p<0.05), while living alone and heavy drinking were associated with poor sleep quality (p<0.05).

Supplementary Table S1 shows results for the association of socio-demographic, behavioural and psychological factors with socioeconomic indicators. Men with lowest vs highest SES were less likely to be employed full time and to be born in Switzerland, and more likely to follow unhealthy behaviours and suffer from psychological disturbances. Similar patterns were observed among women although social differences in psychological factors were weaker in women than men.

Table 3 shows prevalence ratios (PR) of sleep disturbances in the lowest compared to the highest SES groups. Men with a low educational level or occupational position were more likely to suffer from poor sleep quality, short sleep duration and insomnia (p<0.001). Men with a low occupational position were also more likely to have long sleep latency (PR=4.90, 95% CI: 2.14–11.17). Women with a low educational level were more likely to have long sleep latency and short sleep duration (PR=2.09, 95% CI: 1.31–3.35 and PR=2.26, 95% CI: 1.33–3.84). Associations were stronger for occupational position, and women with a low occupational position tended to suffer from all sleep disturbances examined (p<0.10), but did not report a higher use of sleep medications. In general, the association between SES and sleep disturbances was not altered by adjustment for the potential mediators examined, with the possible exception of the association between occupational position and long sleep latency in men (% attenuation=22% in the fully adjusted model).

Polysomnography (HypnoLaus)

The association of objectively assessed sleep characteristics (PSG) with SES in the Hypnolaus sub-set of participants (N=1569) is presented in Fig. 2. Because of a lack of power, men and women were analysed together. No between-SES differences were observed for total sleep time. Sleep efficiency, a general indicator of sleep quality, was significantly lower in participants with low SES for both SES indicators (p<0.001). Participants with low SES also had higher stage shifts (indicating unstable sleep) for both SES indicators (p<0.001). A significant trend towards a decrease in deep sleep in participants with lower education was also observed, even though the absolute difference (<2%) remains rather small.

Several additional sensitivity analyses were conducted to evaluate the impact of missing data on our results. Analyses were rerun using multiple multivariate imputation (STATA procedures “ice/micombine”). This procedure replaces missing values with imputed values allowing analyses to be conducted on the entire sample (N=5064). Results on the imputed sample were similar to those reported in the main analysis

(Supplementary Table S2). We also used inverse probability weighting to correct the estimates for missing response. These analyses yielded similar results to those reported in the main analysis (results available upon request).

Discussion

In this study we examined the association of SES with several sleep outcomes, namely sleep quality, latency, duration and efficiency, daytime sleepiness and insomnia, slow wave sleep and stage shifts, and use of sleep medications. We confirm that both subjectively and objectively measured sleep disturbances are frequent in the population but not equally distributed across socioeconomic strata, with people with a low SES sharing the highest burden. The association of SES with sleep disturbances was particularly strong for occupational position, and was marginally explained by psychological factors but not by the other included socio-demographic behavioural factors.

A very high prevalence of sleep disturbances was found, in line with results reported in most high-income countries [45]. Indeed, in our study approximately 30% of men and 40% of women had poor sleep quality, and approximately one out of three participants (men and women) reported short sleep duration and/or insomnia, a finding in agreement with other studies [46,47]. Also in agreement with the existing literature, our findings confirm that sleep complaints are more common in women than in men, and among individuals living alone [48,49]. Psychological factors were also strongly related to poor sleep, a finding also in agreement with the literature [21,28].

Conversely, no association was found between behavioural factors and poor sleep. This result is unexpected as behavioural factors, and obesity in particular, have been strongly related to sleep disturbances in previous studies [50,51], although the direction of this association remains unclear [52]. It is also possible that obese participants in this sample are metabolically healthier than those in other cohorts. This possibility should be further explored. Moreover, it should be noted that the prevalence of obesity is relatively low in our population comparing to that found in other European regions. This is confirmed by a recent OECD report that showed that obesity rates are low in Switzerland, relative to most OECD countries [53].

In this study, we assessed two indicators of SES (occupational position and education) in relation to sleep disturbances. Low SES was strongly associated with poor sleep quality using both indicators. With the exception of daytime sleepiness and use of sleep medications, low occupational position was strongly associated with all sleep disturbances. In particular, women with a low occupational position were 30% more likely than those with a high occupational position to have poor sleep quality, 2.5-times more likely to have long sleep latency, 2-times more likely to suffer from daytime sleepiness, 3-times more likely to have

short sleep duration and 30% more likely to suffer from insomnia. Education showed a similar pattern, but associations were generally weaker.

This study is in line with the existing literature showing a higher burden of sleep disturbances among low SES individuals [24–29]. In addition, this is one of the first studies to use both subjective and objective evaluations of sleep in relation to SES. In general, results from sleep questionnaire and PSG were consistent in indicating that individuals with a low SES present a higher burden of sleep disturbances. Interestingly, we found SES differences in sleep duration among women in subjective evaluations but not in PSG. This may be related, first, to the fact that analysis of objective sleep were conducted in men and women together, and second to the fact that a subjective evaluation of sleep may be influenced by underlying psychological and health characteristics that might in turn be patterned by SES. Moreover, objective sleep measurement (PSG) was conducted during a single night whereas subjective sleep duration related to usual sleep schedules.

This study specifically points to the work dimension of SES (low occupational position) as a major driver of sleep disturbances. Several factors may explain this strong relationship. First, job-related psychosocial stress has been related to poor sleep [54] and is also more common among people with a low vs high occupational position [55], thus potentially explaining the SES-sleep association. Second, people with a low occupational position may be more exposed to shift work [56,57] which is known to affect circadian rhythms with negative consequences on sleep[58]. Unfortunately, information on job characteristics was not available in our studies and we could not account for these factors. Finally, working women with a low occupational position may particularly suffer from the combination of work and family responsibilities, with negative consequences on sleep [59], as they may lack the job flexibility or financial capacities of their more advantaged counterparts. Indeed, previous studies have reported sleep deprivation among women of low SES (women manual workers in particular), but not among men regardless of social class, nor among women of more advantaged social classes [60,61]. In our study, we could not account for women's workload and for work and family demand, but this explanation might be confirmed by the fact that results for the association between education and sleep (that also included non-working women) were weaker than for occupational position. Interestingly and in contrast with previous studies [33,62], in this population use of sleep medications was not related to SES.

In our study, social differences in sleep disturbances were only marginally accounted for by social variations in socio-demographic characteristics other than SES, as well as by behavioural and psychological factors. Accordingly, these factors are unlikely to be mediators of the association between SES and sleep disturbances. This finding is in line with other studies [28,29]. However, one study reported a more prominent role of psychological factors [27]. The lack of a mediating role of behavioural factors can be

explained by the fact that they were, if anything, only moderately associated with sleep outcomes. As discussed earlier, other important factors such as job characteristics, shift work, stress, family commitments, and financial difficulties may explain the observed social differences in sleep disturbances [63,64]. However, the contribution of these factors could not be examined in this study.

Strengths and limitations

This study has several strengths. First, it was based on a population-based sample. Second, unlike most previous studies, it assessed two indicators of SES in relation to a variety of sleep disturbances. Third, we explored the contribution of several potential mediators of the association between SES and sleep. Most importantly, we were able to additionally assess social differences in objectively measured sleep characteristics (PSG) on a sub-sample of the study population.

This study also has several limitations that should be considered in interpreting results. Although data are drawn from a population-based sample, the participation rate was low, and the study population was further reduced because of missing values on sleep outcomes and other covariates. As both non-participation and incomplete data may be higher in participants with low SES, it is possible that the most disadvantaged fraction of society is underrepresented in this study, which would lead to an underestimation of the prevalence of sleep disturbances. However, sensitivity analyses assessing the impact of missing data on our results yielded similar results to those of the main analysis. Another limitation is the fact that objective measurements of sleep were only available for a sub-sample of the population, leading to a decrease in sample size and in statistical power. Thus, and in order to maintain an adequate statistical power, analyses on objective sleep were conducted in men and women together. Importantly, they confirmed poorer sleep among participants with low SES. Although we explored a variety of factors potentially contributing to the association of SES with sleep disturbances, some important factors such as the job characteristics mentioned earlier were not available and their contribution could not be assessed. Moreover, the presence of mental disorders such as depression was not assessed using a structured diagnostic interview.

In conclusion, low SES and in particular low occupational position, is strongly related to subjectively and objectively measured sleep disturbances. This study should raise awareness among health practitioners about the higher prevalence of sleep disturbances among socioeconomically disadvantaged individuals. The association of SES with sleep disturbances persisted after adjustment for other socio-demographic, behavioural and psychological factors. Further research should assess the role of other potential mediators of this association such as job characteristics (including workload, shift-work, and work-family demand) and psychological and financial stress. Moreover, considering the adverse consequences of sleep disturbances

on several major health outcomes [1–8], further research is needed to establish the extent to which social differences in sleep contribute to explain socioeconomic differences in health.

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Conflicts of interest

The authors have no conflict of interest to declare.

Ethics statement

The Institutional Ethics Committee of the Faculty of Medicine of the University of Lausanne approved the CoLaus study. All participants signed a written informed consent after having received a detailed description of study objectives.

Appendix: Supplementary data

Supplementary data to this article can be found online at

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References

1. Mullington JM, Haack M, Toth M, Serrador JM, Meier-Ewert HK. Cardiovascular, inflammatory, and metabolic consequences of sleep deprivation. Prog Cardiovasc Dis 2009;51:294-302.
2. Knutson KL, Spiegel K, Penev P, Van Cauter E. The metabolic consequences of sleep deprivation. Sleep Med Rev 2007;11:163-78.
3. von Ruesten A, Weikert C, Fietze I, Boeing H. Association of sleep duration with chronic diseases in the European Prospective Investigation into Cancer and Nutrition (EPIC)-Potsdam study. PLoS ONE 2012;7:e30972.
4. Nebes RD, Buysse DJ, Halligan EM, Houck PR, Monk TH. Self-reported sleep quality predicts poor cognitive performance in healthy older adults. J Gerontol B Psychol Sci Soc Sci 2009;64:180-7.
5. Blackwell T, Yaffe K, Ancoli-Israel S, et al. Poor sleep is associated with impaired cognitive function in older women: the study of osteoporotic fractures. J Gerontol A Biol Sci Med Sci 2006;61:405-10.
6. Lucidi F, Mallia L, Violani C, Giustiniani G, Persia L. The contributions of sleep-related risk factors to diurnal car accidents. Accid Anal Prev 2013;51:135-40.
7. Howard ME, Desai AV, Grunstein RR, et al. Sleepiness, sleep-disordered breathing, and accident risk factors in commercial vehicle drivers. Am J Respir Crit Care Med 2004;170:1014-21.
8. Uehli K, Mehta AJ, Miedinger D, et al. Sleep problems and work injuries: A systematic review and meta-analysis. Sleep Med Rev 2014;18:61-73.
9. Schmid SM, Hallschmid M, Schultes B. The metabolic burden of sleep loss. The Lancet Diabetes & Endocrinology 2014.
10. National Sleep Foundation. 2013 International Bedroom Poll. 2013 [cited 07.01.2013]; Available from: http://www.sleepfoundation.org/sites/default/files/RPT495a.pdf
11. Bixler EO, Kales A, Soldatos CR, Kales JD, Healey S. Prevalence of sleep disorders in the Los Angeles metropolitan area. Am J Psychiatry 1979;136:1257-62.

12. Rowshan Ravan A, Bengtsson C, Lissner L, Lapidus L, Bjorkelund C. Thirty-six-year secular trends in sleep duration and sleep satisfaction, and associations with mental stress and socioeconomic factors—results of the Population Study of Women in Gothenburg, Sweden. J Sleep Res 2010;19:496-503.
13. Bin YS, Marshall NS, Glozier N. Secular trends in adult sleep duration: a systematic review. Sleep Med Rev 2012;16:223-30.
14. Talala KM, Martelin TP, Haukkala AH, Harkanen TT, Prattala RS. Socio-economic differences in self-reported insomnia and stress in Finland from 1979 to 2002: a population-based repeated cross-sectional survey. BMC Public Health 2012;12:650.
15. Ferrie JE, Kumari M, Salo P, Singh-Manoux A, Kivimaki M. Sleep epidemiology—a rapidly growing field. Int J Epidemiol 2011;40:1431-7.
16. Grandner MA, Pack AI. Sleep disorders, public health, and public safety. JAMA 2011;306:2616-7.
17. Sigurdson K, Ayas NT. The public health and safety consequences of sleep disorders. Can J Physiol Pharmacol 2007;85:179-83.
18. Pandi-Perumal SR, Seils LK, Kayumov L, et al. Senescence, sleep, and circadian rhythms. Ageing Res Rev 2002;1:559-604.
19. Klink M, Quan SF. Prevalence of reported sleep disturbances in a general adult population and their relationship to obstructive airways diseases. Chest 1987;91:540-6.
20. Ohayon MM, Sagales T. Prevalence of insomnia and sleep characteristics in the general population of Spain. Sleep Med 2010;11:1010-8.
21. Knutson KL. Sociodemographic and cultural determinants of sleep deficiency: implications for cardiometabolic disease risk. Soc Sci Med 2013;79:7-15.
22. Ohayon MM. Prevalence and correlates of nonrestorative sleep complaints. Arch Intern Med 2005;165:35-41.
23. Young T, Skatrud J, Peppard PE. Risk factors for obstructive sleep apnea in adults. JAMA 2004;291:2013-6.
24. Jarrin DC, McGrath JJ, Silverstein JE, Drake C. Objective and subjective socioeconomic gradients exist for sleep quality, sleep latency, sleep duration, weekend oversleep, and daytime sleepiness in adults. Behav Sleep Med 2013;11:144-58.
25. Grandner MA, Patel NP, Gehrman PR, et al. Who gets the best sleep? Ethnic and socioeconomic factors related to sleep complaints. Sleep Med 2010;11:470-8.
26. Ertel KA, Berkman LF, Buxton OM. Socioeconomic status, occupational characteristics, and sleep duration in African/Caribbean immigrants and US White health care workers. Sleep 2011;34:509-18.
27. Anders MP, Breckenkamp J, Blettner M, Schlehofer B, Berg-Beckhoff G. Association between socioeconomic factors and sleep quality in an urban population-based sample in Germany. Eur J Public Health 2013.
28. Arber S, Bote M, Meadows R. Gender and socio-economic patterning of self-reported sleep problems in Britain. Soc Sci Med 2009;68:281-9.
29. Stamatakis KA, Kaplan GA, Roberts RE. Short sleep duration across income, education, and race/ethnic groups: population prevalence and growing disparities during 34 years of follow-up. Ann Epidemiol 2007;17:948-55.
30. Moore PJ, Adler NE, Williams DR, Jackson JS. Socioeconomic status and health: the role of sleep. Psychosom Med 2002;64:337-44.
31. Adams J. Socioeconomic position and sleep quantity in UK adults. J Epidemiol Community Health 2006;60:267-9.
32. Van Cauter E, Spiegel K. Sleep as a mediator of the relationship between socioeconomic status and health: a hypothesis. Ann N Y Acad Sci 1999;896:254-61.

33. Sekine M, Chandola T, Martikainen P, McGeoghegan D, Marmot M, Kagamimori S. Explaining social inequalities in health by sleep: the Japanese civil servants study. J Public Health (Oxf) 2006;28:63-70.
34. Firmann M, Mayor V, Vidal PM, et al. The CoLaus study: a population-based study to investigate the epidemiology and genetic determinants of cardiovascular risk factors and metabolic syndrome. BMC Cardiovasc Disord 2008;8:6.
35. Buysse DJ, Reynolds CF, 3rd, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. Psychiatry Res 1989;28:193-213.
36. Johns MW. A new method for measuring daytime sleepiness: the Epworth sleepiness scale. Sleep 1991;14:540-5.
37. Iber C, Ancoli-Israel S, Chesson A, Quan SF, for the American Academy of Sleep Medicine. The AASM Manual for the Scoring of Sleep and Associated Events: Rules, Terminology and Technical Specifications. 1st ed. Westchester, Illinois: American Academy of Sleep Medicine, 2007.
38. Bernstein M, Sloutskis D, Kumanyika S, Sparti A, Schutz Y, Morabia A. Data-based approach for developing a physical activity frequency questionnaire. Am J Epidemiol 1998;147:147-54.
39. Radloff LS. The CES-D Scale: A Self-Report Depression Scale for Research in the General Population. Applied Psychological Measurement 1977;1:385-401.
40. Van Dam NT, Earleywine M. Validation of the Center for Epidemiologic Studies Depression Scale—Revised (CESD-R): pragmatic depression assessment in the general population. Psychiatry Res 2011;186:128-32.
41. Khang YH, Yun SC, Lynch JW. Monitoring trends in socioeconomic health inequalities: it matters how you measure. BMC Public Health 2008;8:66.
42. Barros AJ, Hirakata VN. Alternatives for logistic regression in cross-sectional studies: an empirical comparison of models that directly estimate the prevalence ratio. BMC Med Res Methodol 2003;3:21.
43. Coutinho LM, Scazufca M, Menezes PR. Methods for estimating prevalence ratios in cross-sectional studies. Rev Saude Publica 2008;42:992-8.
44. Stringhini S, Batty GD, Bovet P, et al. Association of Lifecourse Socioeconomic Status with Chronic Inflammation and Type 2 Diabetes Risk: The Whitehall II Prospective Cohort Study. PLoS Med 2013;10:e1001479.
45. Institute of Medicine (US) Committee on Sleep Medicine and Research. Sleep Disorders and Sleep Deprivation: An Unmet Public Health Problem. Washington (DC), 2006.
46. Delini-Stula A, Bischof R, Holsboer-Trachsler E. Sleep behavior of the Swiss population: Prevalence and the daytime consequences of insomnia. Somnologie 2007;11:193-201.
47. Ohayon MM. Epidemiology of insomnia: what we know and what we still need to learn. Sleep Med Rev 2002;6:97-111.
48. Troxel WM, Buysse DJ, Matthews KA, et al. Marital/cohabitation status and history in relation to sleep in midlife women. Sleep 2010;33:973-81.
49. Arber S. Gender, marital status and sleep problems in Britain. Przegl Lek 2012;69:54-60.
50. Patel SR, Blackwell T, Redline S, et al. The association between sleep duration and obesity in older adults. Int J Obes (Lond) 2008;32:1825-34.
51. Vgontzas AN, Bixler EO, Chrousos GP. Obesity-related sleepiness and fatigue: the role of the stress system and cytokines. Ann N Y Acad Sci 2006;1083:329-44.
52. Gangwisch JE, Malaspina D, Boden-Albala B, Heymsfield SB. Inadequate sleep as a risk factor for obesity: analyses of the NHANES I. Sleep 2005;28:1289-96.
53. OECD Health Division. OBESITY Update 2014, 2014.

54. Knudsen HK, Ducharme LJ, Roman PM. Job stress and poor sleep quality: data from an American sample of full-time workers. Soc Sci Med 2007;64:1997-2007.
55. Marmot MG, Bosma H, Hemingway H, Brunner E, Stansfeld S. Contribution of job control and other risk factors to social variations in coronary heart disease incidence. Lancet 1997;350:235-9.
56. Schernhammer ES, Laden F, Speizer FE, et al. Night-shift work and risk of colorectal cancer in the nurses' health study. J Natl Cancer Inst 2003;95:825-8.
57. Vyas MV, Garg AX, Iansavichus AV, et al. Shift work and vascular events: systematic review and meta-analysis. BMJ 2012;345:e4800.
58. Haus E, Smolensky M. Biological clocks and shift work: circadian dysregulation and potential long-term effects. Cancer Causes Control 2006;17:489-500.
59. Lallukka T, Rahkonen O, Lahelma E, Arber S. Sleep complaints in middle-aged women and men: the contribution of working conditions and work-family conflicts. J Sleep Res 2010;19:466-77.
60. Artazcoz L, Borrell C, Benach J. Gender inequalities in health among workers: the relation with family demands. J Epidemiol Community Health 2001;55:639-47.
61. Artazcoz L, Borrell C, Benach J, Cortes I, Rohlfs I. Women, family demands and health: the importance of employment status and socio-economic position. Soc Sci Med 2004;59:263-74.
62. Omvik S, Pallesen S, Bjorvatn B, Sivertsen B, Havik OE, Nordhus IH. Patient characteristics and predictors of sleep medication use. Int Clin Psychopharmacol 2010;25:91-100.
63. Sekine M, Chandola T, Martikainen P, Marmot M, Kagamimori S. Work and family characteristics as determinants of socioeconomic and sex inequalities in sleep: The Japanese Civil Servants Study. Sleep 2006;29:206-16.
64. Lallukka T, Ferrie JE, Kivimaki M, Shipley MJ, Rahkonen O, Lahelma E. Economic difficulties and subsequent sleep problems: evidence from British and Finnish occupational cohorts. Sleep Med 2012;13:680-5.

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Fig. 1. Mean values and prevalence of sleep disturbances by socioeconomic indicators in men (*N*=1607) and women (*N*=1784)—subjective sleep. Only 2184 participants who were currently working are included for analyses on occupational position; *p* is for linear trend across socioeconomic categories; all values are adjusted for age.

Fig. 2. Mean values and prevalence of sleep disturbances by socioeconomic indicators (*N*=1569)—objective sleep. Only 1011 participants who were currently working are included for analyses on occupational position; *p* is for linear trend across socioeconomic categories; all values are adjusted for age and sex.

Table 1

Characteristics of participants included in the study, by sex (the CoLaus study).

	MEN	WOMEN	p^a
N (%)	**1607 (47.4)**	**1784 (52.6)**	
Socio-demographic factors, *N* (%)			
Age >70 years	207 (12.9)	205 (11.5)	*0.216*
Employed full time	1093 (68.3)	965 (54.4)	***<0.001***
Married/cohabiting	1102 (68.6)	882 (50.6)	***<0.001***
Born in Switzerland	1061 (66.0)	1184 (66.4)	*0.832*

Behavioral factors, *N* (%)			
Current smoking	345 (21.5)	358 (20.1)	*0.318*
Heavy drinking	148 (9.2)	84 (4.7)	***<0.001***
Sedentary	529 (32.9)	573 (32.1)	*0.620*
High coffee consumption	64 (4.0)	56 (3.2)	*0.181*
Obesity	270 (16.8)	240 (13.5)	***<0.001***
Psychological factors, *N* (%)			
High somatic complaints	245 (15.3)	397 (22.3)	***<0.001***
High depressed effect	126 (7.8)	253 (14.2)	***<0.001***
High dist. Interpersonal Rel	219 (13.6)	249 (14.0)	*0.781*
Positive effect	655 (40.8)	852 (47.8)	***<0.001***
Depression	235 (14.6)	196 (11.0)	***0.002***
Sleep disturbances, *N* (%)			
Poor sleep quality	457 (28.4)	681 (38.2)	***<0.001***
Long sleep latency	86 (5.3)	150 (8.4)	***<0.001***
Excessive daytime sleepiness	197 (12.3)	182 (10.2)	*0.058*
Short sleep duration	141 (8.8)	127 (7.1)	***0.074***
Insomnia	428 (26.6)	616 (34.5)	***<0.001***
Use of sleep medications	247 (15.4)	432 (24.2)	***<0.001***

Sleep quality is derived from the Pittsburg Sleep Quality Index (PSQI), poor sleep quality was considered for PSQI scores >5; *Sleep latency* represents the self-reported length of before falling asleep, >30 minutes was considered long sleep latency; *Daytime sleepiness* is derived from the Epworth Sleepiness Scale, excessive daytime sleepiness was considered for scores >10; *Sleep duration* represents the self-reported average hours of sleep in the previous month, short sleep duration was considered sleeping <5 hours/night; *Insomnia* was considered if participants reported a sleep latency of more than 30 minutes or if they declared having woken up in the middle of the night or too early in the morning; *Use of Sleep Medications* was considered if individuals reported to have used sleep medications at least some times over the previous month.

[a]*p-value* for sex difference.

[b]Only 2184 participants who were currently working are included.

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Table 2

Association of socio-demographic, behavioral and psychological factors with sleep disturbances in men (*N*=1607) and women (*N*=1784) of the CoLaus study.

	MEN						WOMEN					
	Poor sleep quality	**Long sleep latency**	**Excessive daytime sleepiness**	**Short sleep duration**	**Insomnia**	**Use of sleep med**	**Poor sleep quality**	**Long sleep latency**	**Excessive daytime sleepiness**	**Short sleep duration**	**Insomnia**	**Use sle me**
	PR[a]	**PR[a]**	**PR[a]**	**PR[a]**	**PR[a]**	**PR[a]**	**PR[a]**	**PR[a]**	**PR[a]**	**PR[a]**	**PR[a]**	**PR**
Non-working full-time (Ref. Yes)	1.22	**1.87****	0.94	0.90	1.25	1.44*	1.12	1.19	0.91	0.92	1.02	1.0
Living alone (Ref. In couple)	**1.30****	**1.66***	1.09	1.23	1.11	1.59***	**1.15****	1.23	1.03	**1.53***	1.09	1.24
Not born in CH (Ref. born in CH)	**1.25****	**1.98****	1.21	**1.81*****	1.13	1.07	1.18	1.11	**1.43***	1.33	1.06	0.9
Current smoking (Ref. No)	1.09	1.34	1.30	1.11	0.98	1.20	0.96	0.99	0.82	**1.46***	0.86	0.9
Heavy drinking (Ref. No)	**1.30***	1.60	0.81	1.26	1.05	1.17	**1.45****	0.86	**1.76***	1.18	1.27	1.65
Sedentary (Ref. Active)	1.03	1.17	0.71	**0.51****	1.16	1.16	**1.16***	1.16	0.88	**0.55****	1.02	1.2
High coffee consumption (Ref. Low)	1.11	0.58	1.12	1.24	1.10	0.84	0.90	1.79	0.48	1.79	1.05	0.8
Obesity (Ref. Normal weight)	1.13	0.96	0.91	1.37	0.96	1.16	1.13	1.06	1.21	**2.08*****	0.84	1.0
Somatic complaints (Ref. Low)	**3.00*****	**2.98*****	**1.97*****	**2.86*****	**2.51*****	**2.96*****	**2.52*****	**2.28*****	**1.78*****	**2.97*****	**1.86*****	**2.24**
Depressed affect (Ref. Low)	**2.53*****	**3.36*****	**2.13*****	**2.64*****	**2.04*****	**2.56*****	**1.98*****	**1.69****	**1.70****	**2.59*****	**1.43*****	**1.87**
Dist. interpersonal rel. (Ref. Low)	**1.67*****	**2.05****	**1.80*****	**1.85****	**1.60*****	**1.57****	**1.45*****	**1.52***	**1.59****	**1.82****	**1.23***	**1.37**
Positive affect (Ref. High)	**1.97*****	**3.34*****	**1.47****	**1.74****	**1.56*****	**2.11*****	**1.87*****	**1.75*****	**1.55****	**1.74****	**1.40*****	**1.56**
Depression (Ref. No)	**2.83*****	**2.83****	**1.74*****	**2.64*****	**2.30*****	**2.94*****	**2.34*****	**1.94****	**1.64****	**3.24*****	**1.72*****	**2.19**

Sleep quality is derived from the Pittsburg Sleep Quality Index (PSQI), poor sleep quality was considered for PSQI scores >5; *Sleep latency* represents the self-reported length of before falling asleep, >30 minutes was considered long sleep latency; *Daytime sleepiness* is derived from the Epworth Sleepiness Scale, excessive daytime sleepiness was considered for scores >10; *Sleep duration* represents the self-reported average hours of sleep in the previous month, short sleep duration was considered sleeping <5 hours/night; *Insomnia* was considered if participants reported a sleep latency of more than 30 minutes or if they declared having woken up in the middle of the night or too early in the morning; *Use of Sleep Medications* was considered if individuals reported to have used sleep medications at least some times over the previous month.
PR: Prevalence Ratio; Rel: relationships.
* $p<0.05$; ** $p<0.01$; *** $p<0.001$.
[a]Analyses adjusted for age.

Table 3
Association of socioeconomic indicators with sleep disturbances in men (*N*=1610) and women (*N*=1776) of the CoLaus study and contribution of socio-demographic, behavioral and psychological factors.

	MEN				WOMEN			
	Educational level		Occupational position[a]		Educational level		Occupational position[a]	
	PR[b] (95%CI)	%Δ	PR[b] (95%CI)	%Δ	PR[b] (95%CI)	%Δ	PR[b] (95%CI)	%Δ
ep quality								
el 1: Adjusted for age	**1.36 (1.12-1.65)**		**1.68 (1.30-2.17)**		1.03 (0.88-1.21)		**1.29 (1.00-1.67)**	
el 2:Model 1+ socio-demographic factors	**1.35 (1.12-1.64)**	*-1*	**1.62 (1.25-2.10)**	*-7*	1.05 (0.89-1.23)	*NA*	1.28 (0.98-1.65)	*-3*
el 3:Model 1+ behavioral factors	**1.37 (1.12-1.66)**	*2*	**1.72 (1.32-2.24)**	*4*	1.04 (0.88-1.22)	*NA*	**1.30 (1.00-1.69)**	*3*
el 4:Model 1+ psychological factors	**1.32 (1.10-1.58)**	*-10*	**1.63 (1.27-2.09)**	*-6*	1.05 (0.90-1.21)	*NA*	1.25 (0.98-1.59)	*-13*
el 5: Fully adjusted	**1.35 (1.12-1.62)**	*-2*	**1.62 (1.26-2.09)**	*-7*	1.06 (0.91-1.23)	*NA*	1.24 (0.96-1.59)	*-16*
eep latency								
el 1: Adjusted for age	1.47 (0.85-2.52)		**4.90 (2.14-11.17)**		**2.09 (1.31-3.35)**		**2.34 (1.27-4.67)**	
el 2:Model 1+ socio-demographic factors	1.48 (0.87-2.52)	*NA*	**3.92 (1.76-8.73)**	*-14*	**2.16 (1.34-3.50)**	*4*	**2.31 (1.16-4.61)**	*-1*
el 3:Model 1+ behavioral factors	1.34 (0.78-2.29)	*NA*	**4.32 (1.92-9.72)**	*-8*	**2.05 (1.27-3.31)**	*-3*	**2.26 (1.14-4.50)**	*-4*
el 4:Model 1+ psychological factors	1.37 (0.81-2.32)	*NA*	**4.02 (1.76-9.20)**	*-12*	**2.17 (1.36-3.45)**	*5*	**2.27 (1.13-4.55)**	*-4*
el 5: Fully adjusted	1.37 (0.82-2.28)	*NA*	**3.45 (1.60-7.36)**	*-22*	**2.23 (1.37-3.65)**	*9*	**2.21 (1.11-4.40)**	*-7*
e daytime sleepiness								
el 1: Adjusted for age	1.12 (0.81-1.54)		1.34 (0.89-1.99)		1.08 (0.76-1.52)		**2.01 (1.21-3.33)**	
el 2:Model 1+ socio-demographic factors	1.12 (0.81-1.53)	*NA*	1.30 (0.87-1.95)	*NA*	1.15 (0.81-1.63)	*NA*	**2.01 (1.21-3.35)**	*0*
el 3:Model 1+ behavioral factors	1.09 (0.79-1.51)	*NA*	1.28 (0.85-1.93)	*NA*	1.12 (0.79-1.58)	*NA*	**2.07 (1.24-3.47)**	*5*
el 4:Model 1+ psychological factors	1.09 (0.80-1.49)	*NA*	1.22 (0.82-1.84)	*NA*	1.06 (0.75-1.50)	*NA*	**1.94 (1.17-3.21)**	*-5*
el 5: Fully adjusted	1.08 (0.78-1.48)	*NA*	1.17 (0.78-1.76)	*NA*	1.21 (0.85-1.71)	*NA*	**2.05 (1.22-3.47)**	*3*
eep duration								
el 1: Adjusted for age	**2.07 (1.34-3.20)**		**3.03 (1.78-5.18)**		**2.26 (1.33-3.84)**		**3.16 (1.33-7.51)**	
el 2:Model 1+ socio-demographic factors	**2.12 (1.37-3.26)**	*3*	**2.69 (1.58-4.56)**	*-11*	**2.37 (1.39-4.04)**	*6*	**3.06 (1.29-7.23)**	*-3*
el 3:Model 1+ behavioral factors	**2.00 (1.30-3.11)**	*-5*	**2.95 (1.72-5.06)**	*-3*	**2.04 (1.18-3.53)**	*-12*	**2.77 (1.13-6.73)**	*-12*
el 4:Model 1+ psychological factors	**2.03 (1.32-3.11)**	*-3*	**2.95 (1.71-5.07)**	*-3*	**2.10 (1.30-3.74)**	*-3*	**3.11 (1.30-7.46)**	*-1*
el 5: Fully adjusted	**2.07 (1.35-3.18)**	*0*	**2.66 (1.56-4.53)**	*-12*	**2.11 (1.20-3.71)**	*-8*	**2.81 (1.15-6.90)**	*-10*
a								
el 1: Adjusted for age	**1.24 (1.02-1.52)**		**1.47 (1.12-1.93)**		1.10 (0.93-1.32)		1.26 (0.97-1.65)	
el 2:Model 1+ socio-demographic factors	**1.24 (1.01-1.51)**	*-3*	**1.45 (1.10-1.90)**	*-3*	1.11 (0.93-1.32)	*NA*	1.26 (0.96-1.65)	*NA*
el 3:Model 1+ behavioral factors	**1.27 (1.03-1.56)**	*8*	**1.54 (1.16-2.03)**	*11*	1.15 (0.98-1.37)	*NA*	**1.32 (1.00-1.74)**	*NA*
el 4:Model 1+ psychological factors	**1.21 (1.00-1.47)**	*-12*	**1.43 (1.10-1.85)**	*-9*	1.14 (0.96-1.34)	*NA*	1.24 (0.96-1.61)	*NA*
el 5: Fully adjusted	**1.24 (1.02-1.51)**	*-1*	**1.48 (1.14-1.93)**	*-2*	**1.20 (1.00-1.42)**	*NA*	1.29 (0.98-1.68)	*NA*
leep medications								
el 1: Adjusted for age	1.07 (0.81-1.42)		1.09 (0.75-1.59)		0.92 (0.74-1.15)		0.88 (0.63-1.23)	
el 2:Model 1+ socio-demographic factors	1.04 (0.79-1.35)	*NA*	1.02 (0.70-1.49)	*NA*	0.90 (0.73-1.12)	*NA*	0.87 (0.62-1.21)	*NA*
el 3:Model 1+ behavioral factors	1.06 (0.80-1.40)	*NA*	1.05 (0.72-1.54)	*NA*	0.94 (0.75-1.17)	*NA*	0.89 (0.64-1.26)	*NA*
el 4:Model 1+ psychological factors	1.03 (0.76-1.35)	*NA*	1.01 (0.69-1.48)	*NA*	0.95 (0.77-1.17)	*NA*	0.86 (0.62-1.21)	*NA*

el 5: Fully adjusted	0.92 (0.63-1.35)	*NA*	1.07 (0.81-1.42)	*NA*	0.92 (0.74-1.14)	*NA*	084 (0.60-1.19)	*NA*

Socio-demographic factors include employment status, marital status and country of birth. Behavioural factors include current smoking, heavy drinking, physical activity, BMI, and coffee consumption. Psychological factors include somatic complaints, depressed affect, disturbed interpersonal relationships and positive affect derived from CES-D.
BMI: Body Mass Index; CI: Confidence Interval; CH: Switzerland; PR: Prevalence Ratio; NA: Not available.
[a]Only 2184 participants who were currently working are included for these analyses.
[b]Prevalence ratio for lowest vs highest education/occupation.

SUPPLEMENTARY ANALYSES

Fig. S1. Participants included in the present analysis.

Table S1
Association of socio-demographic, behavioral and psychological factors with socioeconomic indicators in men (*N*=1607) and women (*N*=1784).

Table S2
Association of socioeconomic indicators with sleep disturbances in men (*N*=1610) and women (*N*=1776) of the CoLaus study and contribution of socio-demographic, behavioral and psychological factors (analysis with adjustment for use of sleep medications).

Table S3

Association of socioeconomic indicators with sleep disturbances in men (*N*=2357) and women (*N*=2707) of the CoLaus study (analyses using multiple multivariate imputation).

Table S4

Association of socioeconomic indicators with sleep disturbances in men (N=1610) and women (N=1776) of the CoLaus study and contribution of socio-demographic, behavioral and psychological factors (additional adjustment for use of sleep medications).

Abbreviated title: Socioeconomic status and sleep